# Managing Underground Pollution at a Romanian Refinery



**Project Title**: Implementation of a Cleaner Technology to Contain the Underground Pollution by Petroleum Products in the Vicinity of the Astra Romana Refinery in Ploiesti, Romania.
**Leader:** Astra Romana, Ploiesti, Romania
**Partner:** Leggette, Brashears & Graham, Inc., White Plains, NY, USA
**Location:** Ploiesti, Romania
**Project Duration:** September 1999-August 2000
**EcoLinks Project Investment:** Total EcoLinks Project Investment: $74,995
EcoLinks Grant Support: $48,359; Project Team Cost Share Contribution: $26,636

# Best Practice: Transferable Solution

This project is a Best Practice because it demonstrates the feasibility and effectiveness of the American double-pump system for minimizing the environmental impacts of leaked petroleum from oil refineries in Romania. The double pump system, adjusted for local conditions at Astra Romana Refinery through this project, can now be applied to other similar refineries in Romania to help minimize the contamination of soil and water from leaked petroleum. A pilot system was implemented at Astra Romana to recover leaked petroleum from two extraction wells. With this pilot system, five tons of petroleum are successfully recuperated each month. Further, this system is economically attractive. Companies can avoid serious mitigation costs. The simple payback time for a full-scale 10-12 extraction/recovery well system is between 3.5 and 4.5 years.

# Project Summary

The Astra Romana Oil Refinery in Ploiesti, Romania, has been both an economic asset as well as an environmental hazard. First established in 1880, it was the largest private refinery in Romania. Before World War II, there were 12 oil refineries (including Astra Romana) operating in the Ploiesti region. They collectively processed 80 % of the oil in Romania. Astra Refinery processed 30% of this total quantity. In 1939, Astra Romana was responsible for 25% of the total oil processed in Romania. While the oil refineries of the Ploiesti region have provided valuable energy resources, their activities have contributed to water pollution and soil contamination from leaked petroleum with increasing severity since World War II. Bombardments during the war, three major earthquakes, pipeline ruptures, and accidental spills have lead to serious contamination of soil and water resources in and around the active refineries. At Astra Romana, leaked petroleum has accumulated in the free-phase layer above the groundwater table (i.e. up to seven meters deep underground) spreading as far as 400–500 hectares from the processing site. In addition to soil and water contamination, leaked petroleum residues emit hydrocarbon vapors that have human health impacts. People living near Astra Romana have noted the presence of these vapors in their home basements.

Different methods for removing the residual petroleum from soil and water have been attempted. These methods, however, have had deleterious environmental and human consequences and have been energy-intensive. For example, small businesses and private individuals have been removing free-phase petroleum floating on ground water using open excavations. Removal of leaked petroleum through open excavations has spread ground water contamination and increased fire and asphyxiation hazards. Several people have died from vapors released from the excavation sites. Farmland has been destroyed. Mechanically driven mobile belts have also been used to remove leaked petroleum, but have proven to be inefficient. An environmentally sound and economically efficient method for removing and recovering petroleum from the surrounding refineries was desperately needed.

The purpose of this project was to explore an environmentally sound and economically efficient way to minimize petroleum contamination of soil and water resources in Romania. State-of-the-art American technology, the double pump system, was transferred to Romania and tested at the Astra Romana Refinery in Ploiesti. It was used to recover petroleum from contaminated soil and to prevent the spread of further contamination of ground water resources. Compared to other previously used methods, preliminary testing of the double pump system revealed that it is the most effective approach for recovering petroleum and minimizing further contamination of soil and water. The pilot effort successfully demonstrated the removal of ten tons of petroleum from the subsurface after only two months of operation. The two recovery/extraction wells with double pumps can collectively recover 200 liters of petroleum per day. The implementation of a full-scale system involving 10-12 extraction/recovery wells will prevent even further deterioration of soil and water resources by removing 250-300 tons of petroleum per day. A complete double pump system provides savings in avoided mitigation costs and is an attractive investment.

# Project Activities

The goal of this project was to assess and minimize soil and water contamination from petroleum leaked in the vicinity of Astra Romana Refinery. The project consisted of four main activities.

**1. Assessed contaminated areas**

Action: The extent and impact of petroleum contamination in and around the Astra Romana Refinery were determined. Existing files on data gathered from monitoring wells around the refinery were reviewed. Current data on petroleum residues; local soil, water, and land quality; and previous attempts at free-phase petroleum removal were gathered and analyzed.

Product(s): Data on petroleum contamination at Astra Romana.

**2. Conducted spill assessment and developed spill prevention plan**

Action: A spill assessment was conducted. A prevention plan was developed. Field investigations of the oil leakage sites were made. Spill detection and control systems were evaluated and updated to produce a new general plan for spill prevention including recommendations for implementation.

Product(s): Spill monitoring and control plan.

**3. Prepared, installed, and tested the double pump system in two extraction wells**

Action: The double-pump system technology was selected for this site due to the relatively high permeability of the sediments and the large accumulation of petroleum. High-risk contamination areas on the site were evaluated and the most suitable intervention locations were identified. Based on hydrological and geological assessments of these suitable locations, specific procedures for installing extraction/recovery wells were determined. Two wells were drilled and tested for performance.

Hydrocarbon recovery and ground water extraction equipment from the United States was acquired and installed. A control system and two main pumps, a submersible water pump and a petroleum recovery pump, were installed in each extraction/recovery well. The double pump system allows for the safe extraction of petroleum residues floating on the surface of water. The water pump, which extends just below the water table, takes in ground water forming a cone of depression. The smaller product pump located above the water table recovers petroleum floating on top of the water. The cone of depression is maintained by a sensory activated water pump. This allows petroleum residues to accumulate and be continuously removed from the water surface. Further, the spread of contamination is avoided by preventing the movement of ground water and petroleum by continuously pumping water out.

Start-up activities were completed and the system was tested. The monitoring wells were observed for petroleum accumulation. Upon calibration of the pumps and controls, the removal of hydrocarbons was observed and evaluated.

Product(s): 1) Double pump installation in two wells 2) Data on double pump activation results.

**4. Shared information on the use of cleaner technology for environmental remediation and pollution prevention and control**

Action: Information on the application of this technology was shared in several ways. A workshop was conducted, and a public technical report was produced. The workshop on the double pump technology included presentations, a question and answer period, and field visits to the site. A technical report on the project findings regarding the new system was developed. This report was shared at the workshop and is intended for further distribution to local government and the business sector.

Product(s): 1) Public technical report 2) An awareness brochure 3) Slide show presentation 4) Photo album.

# Project Benefits

The project benefits range from successful technology transfer and information sharing to promote the safe clean up of leaked petroleum residues to the reduced spread of leaked petroleum residues in water and soil and economic benefits from reduced mitigation costs. The financial aspects of implementing a full-scale system are also favorable.

**Capacity Building**

This project builds Astra Romana's collaborative capacity as well as the capacity to implement the double pump system at other oil refineries in Romania. During this project, Astra Romana learned to collaborate with a US firm to transfer useful technology and apply it in a local context. Experience doing collaborative projects was gained. In addition to the initial technology transfer and pilot demonstration, the information sharing aspect of this project strengthened the capacity for applying this system throughout Romania. Information regarding the double pump system and applying it in a Romanian context was shared in a workshop and through outreach materials for public distribution.

**Environmental Benefits**

This project demonstrates the removal of leaked petroleum from contaminated areas. As opposed to other attempted methods, the double pump system poses no environmental and human health risks. It also protects against further contamination of water and soil resources in the area surrounding Astra Romana.

The double pump system is an effective tool for removing leaked oil. The two recovery/extraction wells with double pumps can collectively recover 200 liters of petroleum per day. The recovery system implemented at Astra Romana through this project removed ten tons of petroleum residues during its first two months of activation. Implementation of a full-scale system of 10-12 extraction/recovery wells will prevent even further deterioration of soil and water resources by removing 250-300 tons of petroleum per day. By pumping out petroleum residue floating on ground water, the system can prevent further hydrocarbon contamination by significantly reducing free-phase petroleum migration from contaminated areas.

**Economic Benefits**

Operation of the double-pump system for the removal of petroleum from contaminated soil and water resources provides several economic benefits:

- Recovery is more efficient since no additional processing is needed for petroleum separation. With the double pump system, petroleum separation takes place directly in the well;
- Petroleum can be recovered and reprocessed for economic gain; and
- The system has low maintenance costs and requires only medium capital investment.

The largest savings from using this system, however, are from the avoided clean-up costs through the prevention of further contamination. For example:

- Removing ten tons of free-phase petroleum prevents soil contamination from further petroleum movement and allows for a savings of $14,000-$ 45,000, (depending on the soil clean-up technology);
- Removing 10 tons of free-phase petroleum from the subsurface prevents contamination of 8–10 million cubic meters of ground water and allows for a savings of $4–$20 million in water clean-up costs; and
- Leaked petroleum from Astra Romana spread through the soil and water at a rate of 30 meters per year. Installing a complete system of 10-12 extraction/recovery wells would prevent this spread and allow for a total savings of $40,000–$50,000 per year (the value of estimated recovered petroleum that can be reprocessed as crude oil).

The cost of installing a complete system of 10-12 extraction wells at Astra Romana Refinery would amount to approximately $120,000 (including well installation and development, water and petroleum pumps, control panels, power supply and water discharge lines). Yearly operation and maintenance costs for a 10-12 well recovery network would amount to approximately $10,000. Groundwater monitoring costs for a network of 24 monitoring wells adjacent to the extraction/recovery wells adds $3,800-$4,000 annually. The estimated yearly quantity of petroleum recovered from the subsurface through a 10-12 well recovery network is between 250-300 tons (around $40,000–$50,000).

The table below summarizes the financial aspects of the double pump system.

Table 1. Financial analysis for a recovery system involving 12 extraction wells

| | |
|---|---|
| Investment outlays [$] | 120,000 |
| Operation & Maintenance Costs [$] | 10,000 |
| Monitoring [$] | 3,800–4,000 |
| Value of the petroleum recovered [$] | 40,000–50,000 |
| Simple Payback Time [years] | 4.6–3.3 |

The simple payback time is relatively low, not including the benefits of avoiding soil and water contamination.

# Lessons Learned

During this project several lessons were learned about implementing the double pump system in a Romanian context. They include:

- Implementing the double pump pilot scale project proved to be a valuable and low cost way to determine the costs and benefits of implementing a full-scale system.

- A lengthy customs process for importing US goods (i.e., equipment) should be anticipated for initial construction purposes and equipment malfunctions or breakdowns.

- Each target site is different and may require different preparation. The monitoring wells on this site, for instance, had to be cleaned out before the system could be activated.

# Contact Information

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